

DOXA: Smart Recruitment Assistant

Kaavish II:
Final Report
by

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1. Introduction

1.1 Problem Statement

Recruiting professionals has become a modern day challenge for many organisations. 200,000 students graduate with a bachelor's degree each year in Pakistan alone [9]. Hence, organisations are often overwhelmed by a large number of applicants each year, which has lead to several problems. From the general inability to gather enough talents, to the increased pressure and cost of the screening system to eliminate too many unqualified candidates, organisations have been looking for efficient ways to hire professionals.

A good recruitment process involves searching, interviewing, and thoroughly evaluating candidates. When achieved, a successful recruitment process increases the chances of hiring the right candidate for the correct position. For continued success, organizations need to deploy fast recruitment methods while maintaining competitiveness and adapting to a dynamic market environment.

Using personality assessments to screen candidates early on, significantly improves the selection process and when combined with other types of assessments, such as motivation and cognitive ability [24], and structured interviews, the personality assessment provides powerful insights to recruiters' and allows for more effective hiring decisions.

Personality is a scientifically-proven predictor of job performance. Assessing the can-

didates' behavioural tendencies in a work environment allows recruiters to determine whether a candidate will, in fact, be top a performer and whether they'll fit seamlessly in the culture of the company.

A 2016 study [25] by Frank L. Schmidt, which explores practical and theoretical implications of 100 years of research findings regarding selection methods in personnel psychology, found that job experience alone only allows predicting job performance with 16% accuracy, whereas the combination of cognitive ability and personality allows 78% accuracy in future performance prediction.

1.2 Proposed Solution

According to Forbes, turnover can cost employers 33 percent of an employee's annual salary due to hiring of a replacement [11]. Mis-hirings not only cost a company lose of capital, but also lead to inability in reaching the maximum productivity, toxic work culture, damages to the quality of work due to incompetency of employees and loss of morale due to misfits inside a team [1]. According to a survey by Career Advisory & Assessment Services, 95 percent of the recruiters believe that students study the subjects that do not match their personality type, resulting in poor quality of graduate employees. The survey also found that employers focus more on the soft skills of a candidate such as communication, positive attitude, resilience, critical thinking, team working ability, and confidence rather than just their grades [27].

Our project helps solve the issues that companies face due to mis-hiring. Its helps the employer select the best available candidate in the market who not only has the right skills, but will also gel in amongst the rest of the team, positive work environment, and the ability to handle complex situations at work. This helps in increasing the retention rate of employees reducing the turnover cost and also increasing the overall productivity of the company.

Our project also helps prospective candidates find the ideal jobs for them. Many people do find jobs to work in some company or the other, but often they are not satisfied with their jobs either because their job does not match their interest or

because they do not fit right into the company culture. According to statistics by GoRemotely, a leading site to find remote jobs, 60 percent of employees consider their colleagues to be the biggest contributors to job happiness and 33 percent of employees state that their reason for dissatisfaction at work is boredom [5].

Our project aims to smoothen the recruitment process so much that candidates will not have to run after the recruiter and bug them on LinkedIn or through emails, and the employers will not have to go through the menial task of reviewing hundreds of applications for each job opening. If a recruitment takes place through our product, the employee and the job will be the perfect match for each other and the employee will be there to stay and work at their full potential.

1.3 Intended User

Our project is targeted towards two types of audience.

The first is the **employers** who are trying to find candidates that are best suited for the vacant roles in their companies. Ideally, the HR department of the firms should use this system to post jobs and find the best skilled candidates that also increase the team chemistry in the company. This helps reduce the high amount of turnover costs the companies face.

The second audience for our project are the **candidates** in search for jobs that suit their skills and personality. They are not only ensured to receive the best suited jobs for them, but also with a healthier work environment where they can gel in better and perform to their max potential.

1.4 Project gantt chart and deliverables

The below mentioned gantt chart is in relation to the proposed deliverables and their timeline as mentioned in DOXA: Smart Recruitment Assistant Project Proposal. The following tables represent our weekly timeline stating the milestones and deliverables over the period of two semesters (Fall'21 and Spring'22).

Tasks	Kaavish I - Timeline														
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15
Project Proposal Presentation															
Literature Review (Module I)															
Module I - Brainstorming															
Exploratory Data Analysis (Module I)															
Development of wireframes															
Working on Use Cases															
Working on Functional/Non-Functional Requirements															
Data Preprocessing (Module I)															
Setting up database for web application															
Bulding the machine learning model (Module II)															
Fine Tuning Model															
Frontend/Backend development (Module I)															
Working on UML and ERD															
Exam preparation															

Figure 1.1: Kaavish I Gantt Chart

Tasks	Kaavish II - Timeline														
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15
Literature Review (Module II)															
Module II - Brainstorming															
Analysis of Results of Module I															
Data Preprocessing (Module II)															
Frontend/Backend development (Module II)															
Bulding the machine learning model (Module II)															
Mid-semester video update															
Fine Tuning Model															
Computing Model Accuracy															
Preparation of Reports															
Preparation of poster and presentation															
Exam Preparation															

Figure 1.2: Kaavish II Gantt Chart

1.5 Key Challenges

- One of our major concerns was the lack of knowledge of the different psychotypes and the unavailability of the evaluation metrics of different cognitive ability tests that we will be working on. However, our external supervisor has ensured us that all our group will be provided support by connecting us with psychometricians. Hopefully, this should not be a problem given the fact we have experts in the field we can reach out to if we run into any problems as such.
- Training image data using computer vision models require a lot of time. Some complex models which take several days to train end up showing a significantly lower accuracy (such as 50% - 55%). Fine tuning of these models can only take place once these models are trained. Once changes to the model are made, it has to be retrained which takes similar time as before. To counter this, our external supervisor has granted us access to NVIDIA Tesla GPU which will help in training the models in shorter time.
- According to several research papers, the images from dataset that we initially used for our emotion recognition model were wrongfully classified, This mislabelled data led to poor classification results. To cater this problem, we carried out relabelling of data from a recent research on that dataset which significantly improved our results on the simplest architecture.

2. Literature Review

2.1 Personality Tests in Hiring

In a synchronous validation study of 202 medical clerical roles, the service orientedness of an individuals personality was assessed via a combination of cognitive and perceptual-ability assessments. The authors of [22] attempted to create a selection filter for service professionals that included both cognitive ability tests and a personality exam that was especially meant to identify people who can pass the said filter because of their customer service oriented nature. The selection of personality factors that have a link to work-performance for the position in question is critical to the successful application of personality assessment for employee selection. The major hypothesis in [22] is that personality measurements would be helpful predictors of work success and was validated by the findings, which indicate that personality measures may explain performance variance beyond that accounted for by cognitive ability tests. One apparent aspect in the usage of personality tests is to ensure that they are well-suited for the objective of employee selection; otherwise, they will fail to give satisfactory results.

Many organisations now utilise personality assessments as part of their recruitment process, owing to the high costs associated with making poor hiring decisions and the difficulty of obtaining useful information through a new candidates reference checks [12]. Personality assessments has now turned into a multi-million dollar business. [26] aims to investigate whether personality tests can be utilised as an unbiased, transparent and successful hiring tool. Poor recruiting decision have translated to huge losses in a variety of ways. Employers suffer considerable economic losses as a result of theft and drug usage, estimated to be in the range of 60-98 billion dollars [18]. As a result, the capacity to assess an applicant's honesty or predict the risk

of an employee engaging in harmful substance addiction would be advantageous. Employers do screening, to uncover mental problems or anticipate if a candidate has a predisposition toward violence or other harassing behaviour, out of concern of legal responsibility for negligent hiring or sexual harassment [6]. Personality assessments is used by employers to reduce employ turnover. The cost of a elaborate recruitment process, which include charges for filtering, selection, interviewing and processing, as well training of staff, are substantial. According to [6], the average cost of replacing a wrong hiring is 1.5 times the employee's income, which means that replacing someone earning \$10,000 in salary and benefits might cost \$15,000 in total.

Second, reference checks often fail to offer any useful information to employers. That is primarily because prior employers are wary of disclosing sensitive information about current or departing employees due to the possibility of a defamation lawsuits against the firm or employer. As a result, acquiring an honest and true assessment of a candidate and his work from previous employers is difficult, forcing firms to rely on other alternatives, such as personality tests, to facilitate the recruitment process.[19]

Third, many firms want to be able to screen their applicants for specific attributes that may predict work success or, conversely, that may render an applicant incompatible for the given position. Personality tests then assist firms in their recruitment process to filter applicants with the necessary talents and abilities that also fit into the position's needs, and as a result speeds up the selection process. [26]

The true value of any personality test is only determined by the recruiters ability to identify favorable personality traits for a certain position that will increase the probability of success of the applicant. According to research, Personality traits such as agreeableness and patience, as well as some aggressiveness, are more effective predictors (in contrast to other traits) for most real-world positions, according to researchers [8]. For example tendencies to agreeableness and patience, as well as some aggressiveness, indicate an individual may be fit to become a salesperson a firm.

There is also strong evidence indicating that an employees work- performance is "situationally specific" meaning that an employee's working environment (e.g. office) has a major impact on their performance, behaviour and success [26]. As a result, a workplace with symmetric and complementary personalities will produce a much for friendly, productive and healthy atmosphere.

Fourthly, personality assessments prove fruitful in their ability to filter out good

applicants. Creative people who may possibly become leaders and perform remarkable things for a firm may be weeded out if personality inventories are seeking for mainstream personality types, basically assessing for conformity.[26]

Intelligence, ability, and achievement are all standardised measures of acquired knowledge and skill that show associations with success in numerous aspects of life, including but not limited to academics and professional performance. [7] concludes, by presenting favourable evidence, that the role of personality assessment in assessing an individual's ability is true and correct. Academic and workplace performance are not solely determined by cognitive capacity of an individual. Adding measures of personality, values, interests, and habits to the selection process can greatly improve performance prediction using standardised tests of cognitive ability. Personality qualities such as emotional stability, extroversion, conscientiousness, agreeableness, and openness, indicate a strong correlation with academic success.

Furthermore extensive research on the fairness of assessments like cognitive test, indicate no biasnes especially against women or minority groups, making them an excellent tool to fairly assess individuals in selection processes.[14] [23]

Before selecting a test for a recruitment process, various aspects that may impact the test's outcomes must be considered. The foundation of the test should be based on research and then only it qualifies for use in a recruitment process. Otherwise, the test may prove to be futile to the firm and provide an inaccurate result. This, in turn, can lead to erroneous recruitment's. As a result, it's critical that the chosen test has a high level of reliability and validity [21].

A psychological theory of personality has been used to develop several personality tests. The Carl Jung hypothesis, for example, is based on the Myers-Briggs Type Indicator (MBTI), which revolves around theories about perception and judgement, as well as an individual's attitudes toward each of these variables. Extraversion or introversion, Sensing perception or intuitive perception, Thinking judgement or feeling judgement, Judgment or perception are among the 16 categories that the test assigns to the personalities. Education, counselling, career assistance, and circumstances demanding collaboration and teamwork are just a few of the domains where the MBTI may be beneficial.

The Big-Five Personality Model is the most extensively utilised personality structure model today. Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness are the five personality qualities included in this model. These Big

Five characteristics grow over the course of a person’s life, and their assessments have proven to be quite reliable in areas such as social, occupational, psychological, and health [28]. The Big Five is a self-report or peer-report questionnaire-based assessment that is extensively utilised by Fortune 500 firms.

Several aspects, such as ability and motivation, will influence a person’s professional performance. Furthermore, one of these characteristics that will impact individual success at work is personality. When psychological testing is used to assess a goal with a high degree of reliability and validity, it is appropriate to use it in recruitment and selection roles [3]. In light of these conditions, assessments based on the Big Five Model test and the MBTI personality test are the most researched and acknowledged theories in the field of personality testing.

2.2 Multi-Layer Perceptron

In the real-world many intelligent systems exist. One of the most common jobs executed by an intelligent systems is to perform supervised classification. In the supervised classification the multilayer- perceptron is often the most effective and hence widely utilised. In this method in order to create a classification vector at the network’s output, an input vector or pattern must be learned by the multi-layered perceptron model. A classification vector which contains n values might be used to code a multi-class issue in which the input pattern can be mapped to a target class.

In various disciplines, such as pattern recognition, speech recognition, and multi-classification problems, the multilayer-perceptron offers a wide range of solutions via classification and regression applications. The reason behind the effectiveness of the multi-layer perceptron in such problems is that it learns various degrees of abstraction of data representations through multiple processing layers. In order to accomplish a machine learning task, representation learning or feature learning aims to identify an acceptable representation of the data which can then be used to predict new data. Each hidden layer in multi-layer perceptron, translates its input data to an inner representation that captures a higher degree of abstraction of the data. Overtime, the weight vectors in layers modify themselves via the back-propagation algorithm which translates to learning attributes or features of the data set. With the help of the learnt characteristics the layers get more and more informative as the machine learning model progresses.[16]

Fisher's data, which he used to propose what became known as Fisher's linear discriminant analysis in the 1930s, has been widely utilised as a test data set in the ensuing years. The data comes from 150 iris blossoms that were measured. The 150 blooms are divided into three groups, each with 50 samples. Group one among the three is clearly distinguished from the other two. However, because groups two and three are not linearly separable because they have overlapping features, many linear classification and discriminating fail while some approaches only come close to separating them. Fahlman and Lebiere's cascade-correlation technique, which employs a multilayer perceptron, achieved perfect class separation.

2.3 Facial Emotion Recognition

For emotion recognition of a persons face, the researchers in [20] have developed a very simple two-layer convolution network model. From a data set of many facial images, the model learned to classify facial emotions in 5 distinct categories. The model demonstrated comparable training and validation accuracy, indicating that it is neither over-fitting nor under-fitting hence is generalized to the data set. The loss function for the model was the Adam optimizer, which resulted in about 78 percent accuracy. The model proposed in [20] can be further expanded and improved to identify changes in facial emotion using a video sequence, which can then in turn be utilised for a variety of real-time applications such as feedback analysis, real-time emotion detection, real-time interview analysis etc.

According to [17] it is estimated that about 55% of the time, a person's facial expression can interpret emotion as it is a non-verbal manner of expressing emotion, and hence the facial expressions can be evaluated to be used as determining factors of whether or not the individual is telling the truth. The existing techniques in literature largely focus on exploring the face while keeping the background. This has devastating effects on the training process of convolutional neural networks uncorrelated features are introduced in the model resulting in poor accuracy. [17] introduces FERC as a revolutionary method of detecting facial expressions that combines convolutional neural network and supervised learning with background elimination to improve the accuracy of the obtained results. To greatly improve the accuracy of the FERC model, the author utilised many different datasets and even had to incorporate their own photographs. This however, proved beneficial as significant improvement in the accuracy of the result was noticed.

In recent years, the adoption of a rapid, scalable, end-to-end learning framework, the Convolutional Neural Network, has radically transformed and pushed forward the field of computer vision in recent years. Leading to many state of the art machine learning models that have produced impressive results making it possible to solve problems which were previously unsolvable or difficult to solve accurately [15].

A standard neural network architecture can be improved with the spatial transformer module to enhance the spatial transformation capabilities [13], such as spatially transformed feature maps, conditionals on the feature map itself, with no additional training supervision or optimisation process modification. The authors of [13] noticed advances in accuracy utilising spatial transformers across several tasks, leading in state-of-the-art performance. When applied on the CUB-200-2011 birds data set, the Spatial Transformer-Convolutional Neural Network attained a record accuracy of 84.1%.

This paper [10] demonstrated that basic emotions are primitive, internal states that have gained new meanings and new external behavioral expression via evolution in order to meet organisms' biological, social, and functional needs [2]. Reward, punishment, and stress are the three most primitive features of the four basic emotions (happiness, sadness, fear, anger) and are driven by the three monoamine neuromodulators (DA-reward, 5-HT-punishment, NE-stress). These three monoamines are not only the substrates for the four basic emotions, but we posit that these monoamines combine in varying degrees to ultimately create various higher order emotions, much like the way different colors can be created from the three primary colors; we call this the "Three Primary Color Model of Basic Emotions."

2.4 AI in Hiring

AI is used to perform sentiment analysis of candidates during hiring in order to evaluate whether they are the right fit for the job, as well as determining the honesty of their answers. Some of the employers making use of this technology include the organizations like Boston Red Sox, Carnival Cruise Lines, Dunkin Donuts, IBM, and Unilever.

In the case of Unilever, applicants discover job opportunities via social-media (e.g. LinkedIn, Facebook). They play neuroscience based games to assess their per-

sonalities. After playing those games, they partake in video interviews with preset questions. AI is used to detect and judge their facial expressions and personality traits in the interview. This sentiment analysis software is provided by HireVue.

This approach to the hiring has benefits, for both the employer and the applicant. It makes the process more convenient for everyone involved since the applicant can take the interview at his own accord, and recruiters can review the data whenever feasible. Properly programmed AI does not have the unconscious biases that human recruiters may have. It speeds up the hiring process. This greatly expands the recruitment pool, meaning that companies are able to grab hold of the best candidates, regardless of their background and/or socioeconomic status.

3. Software Requirement Specification (SRS)

This chapter provides detailed specifications of the system under development.

3.1 Functional Requirements

The project has been divided into three modules. The functional requirements are summarised below briefly and worked out in detail under **user stories**.

- **Module 1:**

- Function: User (Candidate/Recruiter) has the ability to create an account.
- Function: Candidates have the ability to set up their profile.
- Function: Candidates have the ability create a resume.
- Function: Candidates have the ability to take a test offered by the application.
- Function: Recruiters will have the ability to view candidate's test results
- Function: Recruiters will have the ability to create job vacancies.
- Function: Candidates can view, search, filter when interacting with multiple vacancies.

- **Module 2:**

- Function: User (Candidate/Recruiter) has the ability to interact with the interview portal.
- Function: Candidates can take part in online interviews as per the requirements of the recruiter.
- Function: Recruiters will have the ability to create a test set for their online interviews.
- Function: Candidates facial emotions will be predicted and added to statistics at the end of the interview.
- Function: Recruiters will have the ability to view the online interview along with the predicted emotions statistics.

- **Module 3:**

This module will contain the wire-frames and the files related to the development of the web application. This module isn't created to serve a specific purpose/function, rather it is created in order to manage the application accordingly. An overview of the module is listed below:

- Front-end: The frontend part of this module will focus on the UI/UX of the webapp.
 - * Candidate Portal: The input for assessments, allowing to sign up for jobs and creating their profile and adding details.
 - * Employer Portal: Post job openings, access applied candidates' relevant details and schedule interviews.
 - * Interview Portal: Allows video interviews between employer and candidate.
- Back-end:
 - * Feeding the data collected to the deep learning models.
 - * Maintaining the database.
 - * Retrieving relevant frames from the interview video of the candidate.

3.1.1 User Stories

EPIC	USER STORY	ACCEPTANCE CRITERIA
USER ACCOUNT	As a candidate, I want to be able to sign up, so I can benefit from the system	Sign up as a candidate button, confirmation email, User is directed to profile page after successful sign up
	As a recruiter, I want to be able to sign up as a representative of my organization, so I can benefit from the system	Sign up as an organization button, confirmation email, user is directed to profile page after successful sign up
	As candidate/recruiter, I want to be able to log in, so I can benefit from the system	2FA, User authentication, User is directed to dashboard after successful log in
USER PROFILE	As a candidate, I want to fill in my personal details, so that I can be identified	Name, Profile Picture, Bio
	As a candidate, I want to list my previous jobs, so that recruiters can view my work experience	Org. Name, Job Designation, Description years worked
	As a candidate, I want to list my skill sets, so that I can showcase my skills to recruiters	
	As a candidate, I want to create my resume, so I can apply to jobs	
	As a recruiter, I want to fill in details about my organization profile, so that it can be identified	Org. name, Logo, Description
	As a candidate, I want to see a list of available tests, so that I can choose from them	A list of available tests is displayed on the user dashboard
ONLINE TESTS	As a candidate, I want to be able to view test details, so that I can prepare for it	Test details are displayed when a test is clicked
	As a candidate, I want to be able to take test(s), so that I can add them to my resume	Take test button with each test
	As candidate, I want to be able to view my detailed test report, so that I can get a better insight about myself	View report button with each test
	As a recruiter, I want to be able to view a candidates detailed test report, to get a better insight about the candidate	View report button with each test in candidates detail profile view

JOB POSTINGS	As a candidate, I want to be notified of new job postings, so I can apply at the earliest	Push notification, email notification
	As a candidate, I want to view a list of job postings, so I can get a sense about the job market	A list of job postings displayed on the user dashboard
	As a candidate, I want to search/filter job postings, so I can find jobs according to my interests	Search bar and filter by displayed on user dashboard
	As a candidate, I want to view job details, so I can get a sense of what the job is about	Job details, like organization name, designation, description, requirements are displayed when a job posting is clicked
	As a candidate, I want to view a jobs requirement, so I can fulfill them	
	As a recruiter, I want to post a job opportunity, so that I can hire some one	New Job Posting button on dashboard
	As a recruiter, I want to specify the domain of the job, so that candidates can get a sense of what the job is	
	As a recruiter, I wan to be able to specify recruitments and tests for a job, so that eligible candidate may apply	
JOB APPLICATION	As a candidate, I want to be able send my resume for a job posting, so I can apply to it	Apply button with each job posting that send user's resume when clicked
	As a recruiter, I want to be notified of new applications, so I can view them at my earliest	Push notification, email notification
	As a recruiter, I want to view a list of applications for a job posting	A list of applicant's baseball cards is displayed when a job posting is clicked
	As a recruiter, I want to view applicants based on their skill set, so that I can arrange them.	Trello like board, to arrange baseball cards
	As a recruiter, I want to view a high-level profile of all applicants, so that the selection process is facilitated	High-level applicant details are nicely displayed in the form of Baseball Cards
	As a recruiter, I want to view a detailed profile of an individual,	Display personal details, skillsets, work experiences,

	so that I can evaluate them further	resume when a baseball card is clicked
ONLINE INTERVIEW	As a candidate, I want to view my upcoming interviews, so I can prepare for them	A list of upcoming interviews is displayed on the dashboard
	As a candidate, I want to be reminded about my upcoming interviews, so I can prepare for them	Push notifications, email notifications
	As a candidate, I want to be able to join an online interview	Join interview button that takes user to the interview portal, where a live stream is initiated via users webcam
	As a candidate, I want to view a detailed report of my interviews, so I can improve	
	As a recruiter, I want to be able to invite candidates to an online interview	
	As a recruiter, I want to view my upcoming interviews, so I can prepare for them.	
	As recruiter, I want to create a question set, so that I can ask them in an interview	
	As a recruiter, I want to be to specify a question set for an interview, so I can evaluate the applicant	Questions displayed in a list in the interview portal, and remarks can be added for each question by the recruiter
	As a recruiter, I want view a detailed report of the applicant during the interview, so I can further evaluate him	Automatic report generation of the applicants facial reactions via ML

Figure 3.1: User Stories

3.2 Non-functional Requirements

Performance	Group of requirements defining the required throughput and response time characteristics of the system.
<ul style="list-style-type: none">• The web application should respond fast (around 1-2 seconds) upon each interaction by the user.• Quick prediction results from each module.	
Usability	Qualitative properties of the final system relating to ease of use, user productivity, user contentment & accessibility support.
<ul style="list-style-type: none">• Responsive Design such that the view is optimized for different screens (mobile, desktop etc).• Simple and user-friendly UI/UX.	
Scalability/Compatibility	Group of requirements defining the scalability and compatibility characteristics of the system.
<ul style="list-style-type: none">• The application must be compatible with all modern browsers.	
Security	Required characteristics & mechanisms to provide system security against misuse / malicious attack / unauthorized access.
<ul style="list-style-type: none">• Personal data withheld in the database must be secured from unauthorized access.• User authentication at login.• Two Factor Authentication (2FA) supported.	
Audit Logging	Audit logging requirements define a sequence of electronic entries that provide a retrievable record for an activity or action in the form of a report.
<ul style="list-style-type: none">• The application must maintain transaction logs for each transaction made by the user.	

Figure 3.2: Non functional requirements

3.3 External Interfaces

3.3.1 User Interfaces

This section includes our mockup screens and briefly explains them.

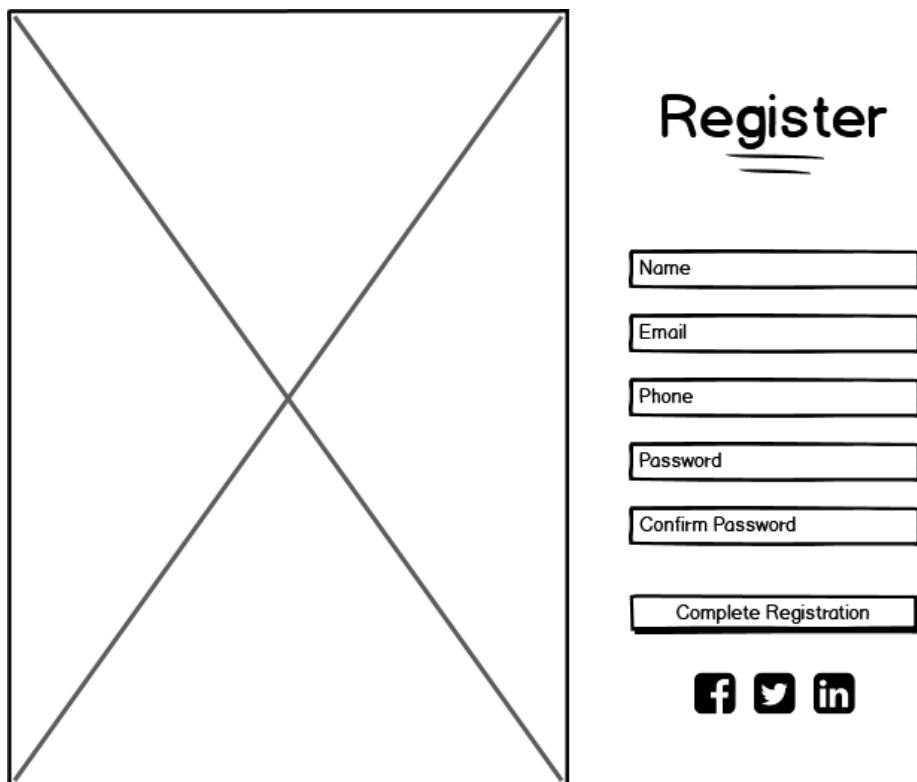


Figure 3.3: Register Page

This page allows the user to register themselves and make an account by providing the mentioned information. They will also be required to set up a 2FA method later on as mentioned in our non functional requirements.

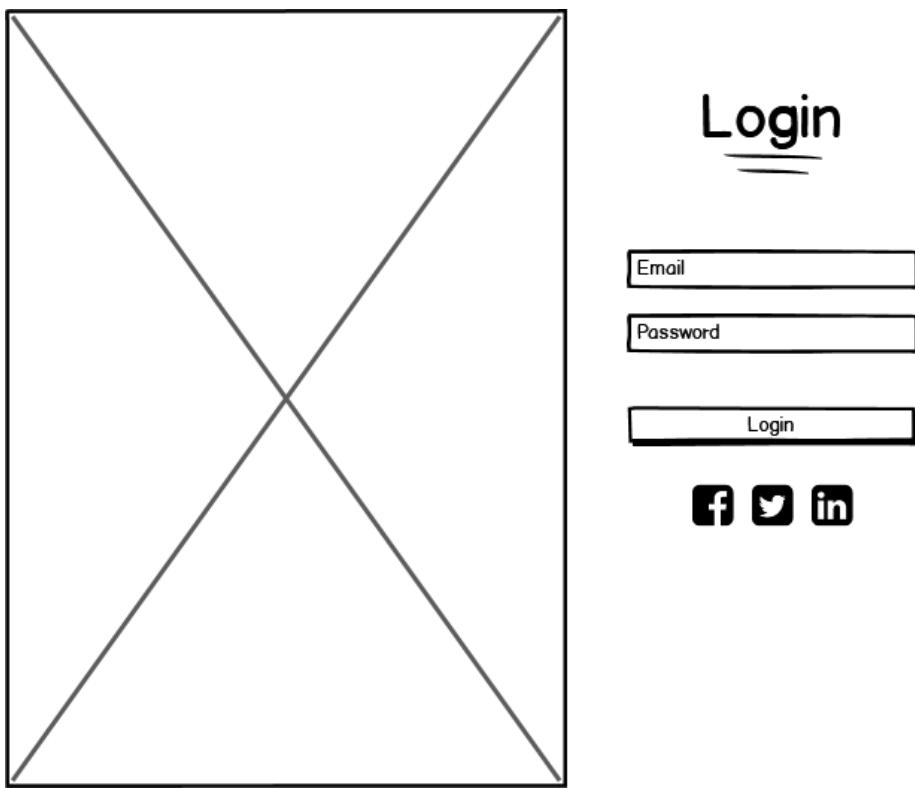


Figure 3.4: Login Page

This page allows the user to login using their account details.

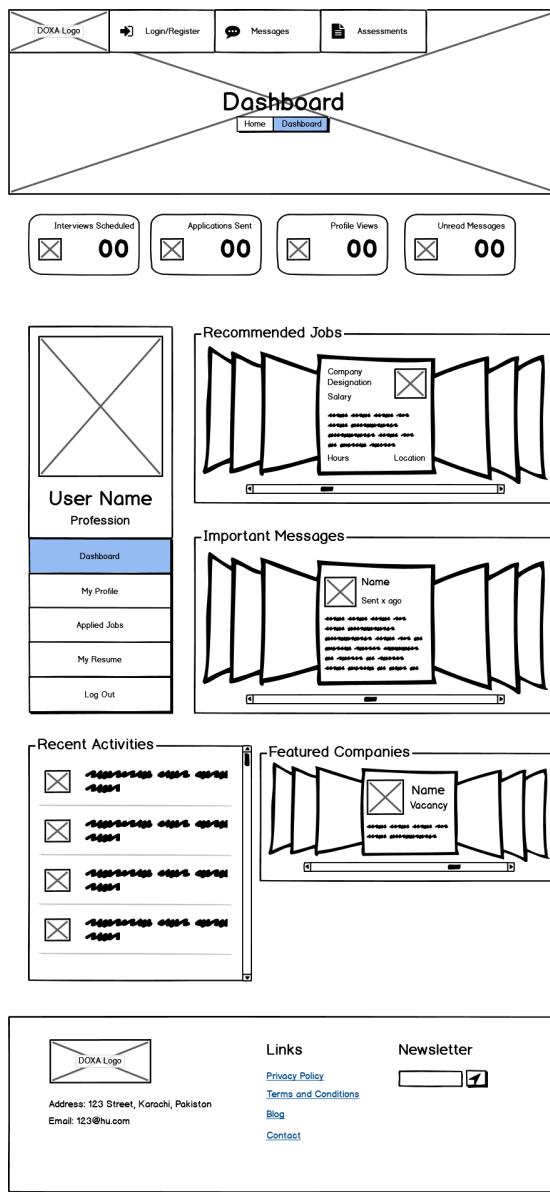


Figure 3.5: User Dashboard

Here, the user information regarding quite a few things, including the jobs postings recommended by the skill classification algorithm, important messages they have received and companies which want themselves to be featured on a specific category users' profiles. The recent activities window includes updates on previous job

postings the user has applied to.

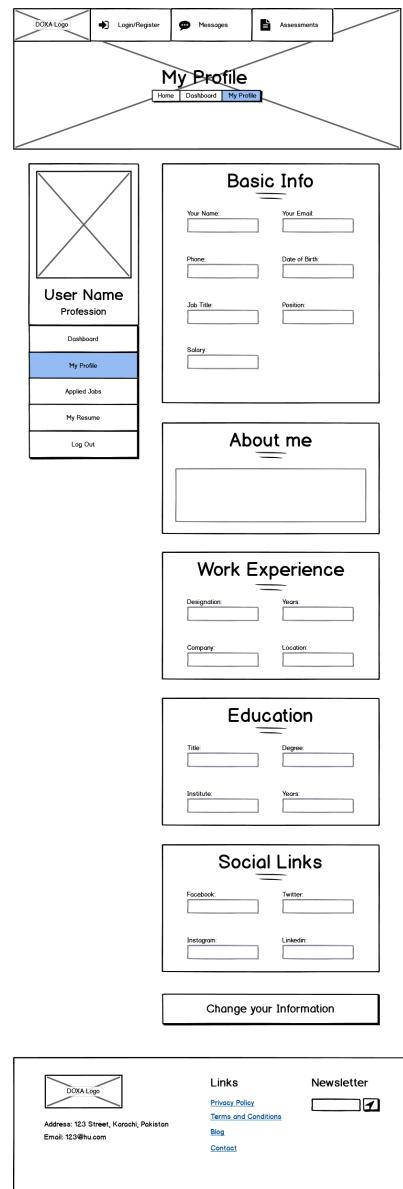


Figure 3.6: My Profile Page
Displays information user has filled in.

The user can view their personal information, such as education and work experience,

here.

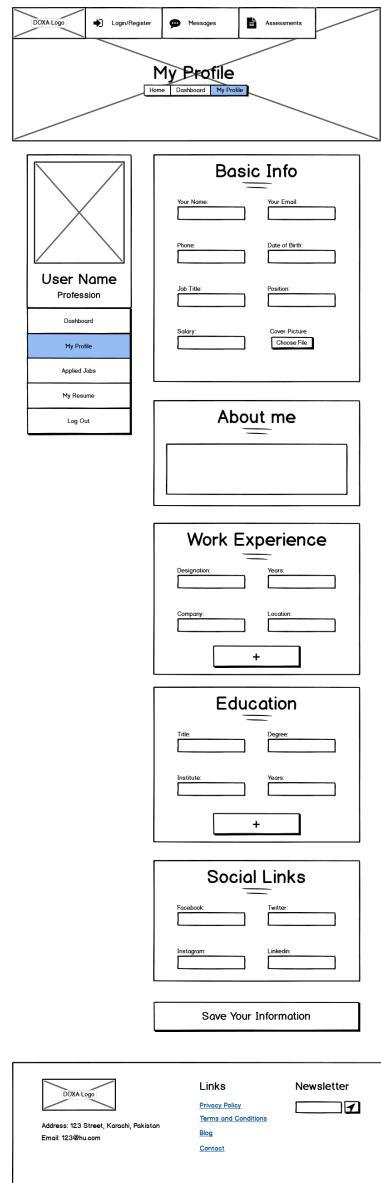


Figure 3.7: Update My Profile Page

The user can update their personal information here.

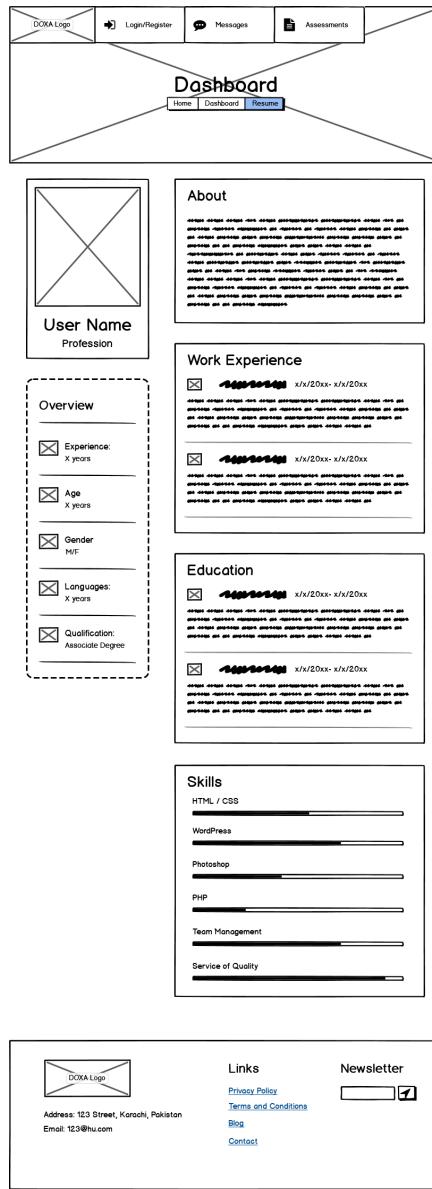


Figure 3.8: Resume Page

The user can view the resume generated from their data they have previously entered.

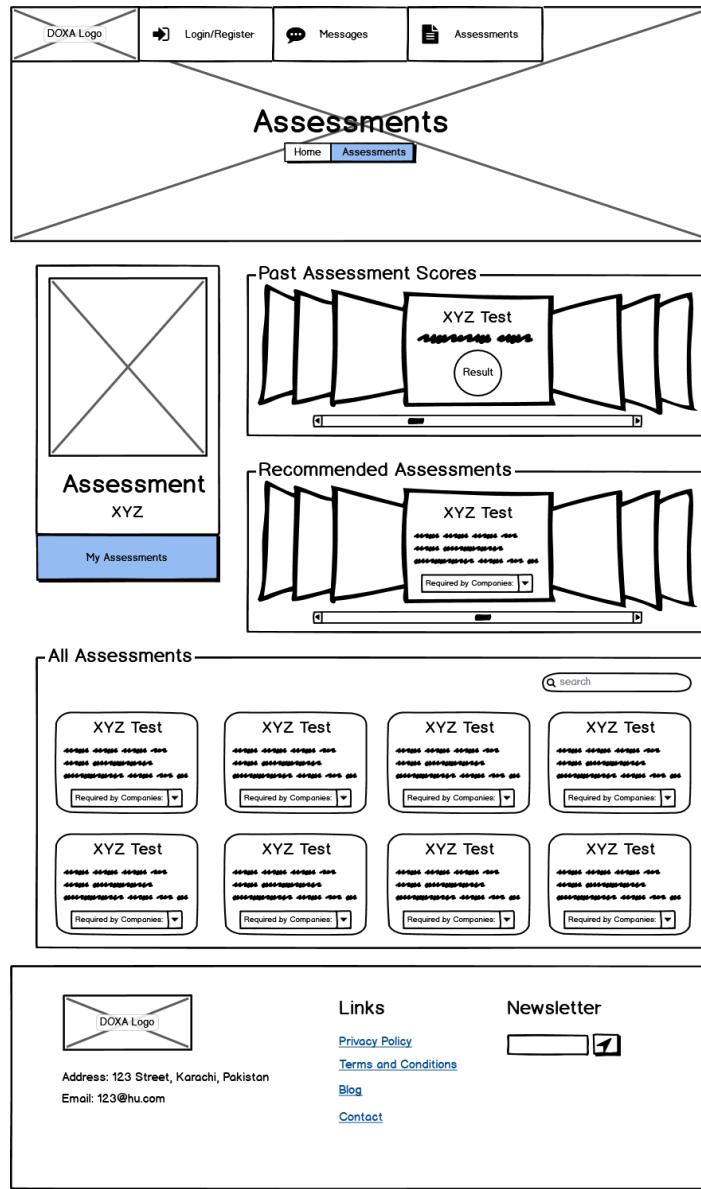


Figure 3.9: My Assessments Page

The user will view past assessment scores and recommended assessments here as well as see which companies require which assessments.


[Login/Register](#)
[Messages](#)
[Assessments](#)

Assessments

[Home](#)
[Assessments](#)
[One Assessment](#)


Assessment XYZ

My Assessments
Assessment In Progress

Complete the Test

Be yourself and answer honestly.

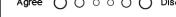
 Agree Disagree

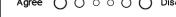
 Agree Disagree

 Agree Disagree

 Agree Disagree

 Agree Disagree

 Agree Disagree

 Agree Disagree

 Agree Disagree

 Agree Disagree

 Agree Disagree

 Agree Disagree

[Next](#)

Figure 3.10: Give Assessment Page

The user will fill in an assessment on this screen.

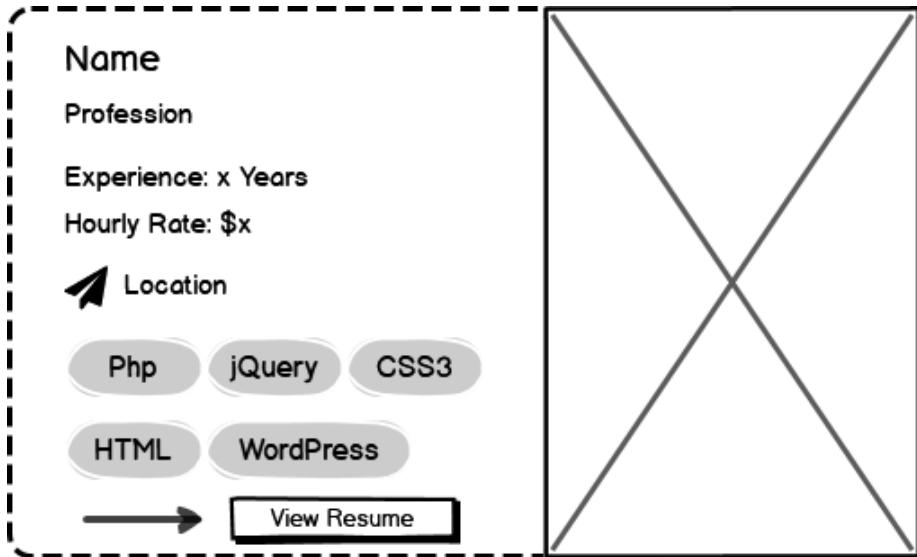


Figure 3.11: Candidate Profile Card

A card showing concise candidate data for employers.

3.3.2 Application Program Interface (API)

Application Programming Interface (API) is used as a protocol for any two different applications to interact, communicate and send/recieve data.

Our application, DOXA, does not interact with any other application as everything in the application, including the assessments and interview modules are developed by us and hosted on our portal, therefore multiple APIs are not needed in this situation.

However, since DOXA's assessments are the result of machine learning algorithms, an API would be needed in order for the application to interact the machine learning algorithms which will be held in a container. An appropriate API suited for this would be the **AutoML API**.

3.3.3 Hardware/Communication Interfaces

Our project does not require any specific Hardware interface. However, for a candidate to take part in an online interview, he/she will be required to use an integrated/external webcam to provide a live video feed of the candidate's face to our application.

A browser application such as Google Chrome, Mozilla Firefox, or Internet Edge will be required for our users to use our application.

3.4 Use Cases

This section presents an overview of the use cases of our system along with its diagram.

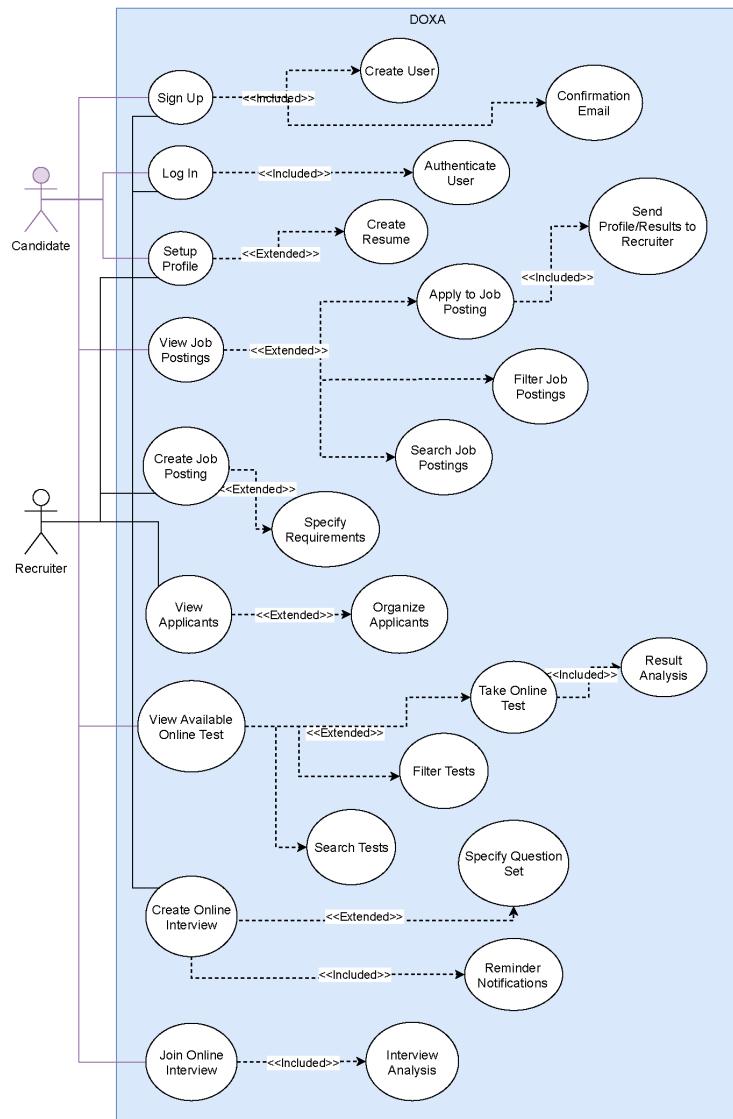


Figure 3.12: Use Case Diagram

ID:	1
Title:	Set Up Profile
Description:	Candidate adds his personal information like name, dob, work experience etc. A recruiter adds information about his organization like organization name, logo etc.
Primary Actor:	Candidate, Recruiter
Preconditions:	User must be logged into the system.
Postconditions:	
Main Success Scenario:	The user has logged into the system and add relevant information (based on the type of user: Candidate, Recruiter) to complete his/her profile.
Extensions:	Candidate is prompted to create a resume automatically, based on his profile.

ID:	2
Title:	Create Resume
Description:	A resume is automatically created based on the candidate's profile
Primary Actor:	Candidate
Preconditions:	Candidate has set up his profile
Postconditions:	
Main Success Scenario:	The candidate has successfully completed his profile setup where he has added his personal information like name, dob, his job experiences and filled a small survey regarding his interests, based on which a resume is automatically created
Extensions:	

Figure 3.13: Use Cases 1 and 2

ID:	3
Title:	View Job Postings
Description:	The candidate can select a particular job posting from a list of job postings
Primary Actor:	Candidate
Preconditions:	The candidate must be logged into the system
Postconditions:	
Main Success Scenario:	The candidate is logged into the system and can select a job posting from a list presented on his dashboard
Extensions:	Candidate can search for a particular job posting, or user filters to narrow down the list of job postings. He can also apply to a job posting

ID:	4
Title:	Apply to a job posting
Description:	Candidate can apply to a selected job posting with a click of a button.
Primary Actor:	Candidate
Preconditions:	Candidate has selected a job posting to view it. Candidate has created his resume and taken required test.
Postconditions:	Candidate profile and test results are submitted as an application to the creator of the job posting.
Main Success Scenario:	Candidate has selected a job posting to view and has decided to apply via a button click. The candidates resume and test results are automatically submitted to the creator of the job posting as an application.
Extensions:	

Figure 3.14: Use Cases 3 and 4

ID:	5
Title:	Create Job Posting
Description:	Recruiter creates a job posting.
Primary Actor:	Recruiter
Preconditions:	Recruiter must be logged into the system. Recruiter must have set up his organization profile.
Postconditions:	Job posting is added to the list of job posting
Main Success Scenario:	The recruiter is logged into the system and has setup his organization profile. He creates a new job posting, where he describes the job and specifies any requirements. The Job posting is then added to the list of job postings to be viewed by candidates.
Extensions:	

ID:	6
Title:	View applicants
Description:	Recruiter can view all applicants in the form of list for a particular job posting.
Primary Actor:	Recruiter
Preconditions:	Recruiter has selected one of his created job postings
Postconditions:	
Main Success Scenario:	Recruiter has selected one of his created job postings, and he can view a list of high-level profiles (baseball card) of the applicants.
Extensions:	Recruiter can organize his applicants in a Trello like board. Recruiter can click on a high-level profile (baseball card) to view a detailed profile of the applicant.

Figure 3.15: Use Cases 5 and 6

ID:	7
Title:	View online test
Description:	Candidate can select an online test from a list of all available online test in the system.
Primary Actor:	Candidate
Preconditions:	Candidate must be logged into the system
Postconditions:	
Main Success Scenario:	The candidate is logged into the system and can select an online test from a list presented on his dashboard
Extensions:	Candidate can search for a particular online test, or use filters to narrow down the list of tests. He can also take a test

ID:	8
Title:	Take online test
Description:	Candidate has selected an online test
Primary Actor:	Candidate
Preconditions:	Candidate must be logged into the system
Postconditions:	An analysis of the candidate's test is performed to create a detailed result.
Main Success Scenario:	The candidate is logged into the system and has selected a test to take it. After completion a detailed analysis is performed to create a detailed report of the candidates result.
Extensions:	

Figure 3.16: Use Cases 7 and 8

ID:	9
Title:	Create Online Interview
Description:	Recruiter creates an online interview for a job posting he created.
Primary Actor:	Recruiter
Preconditions:	Recruiter specifies a set of questions for the interview
Postconditions:	All applicants of the job posting are invited to the job posting. Reminder notifications are sent.
Main Success Scenario:	The recruiter specifies a set of questions, to be asked during the interview All applicants for the job posting are invited.
Extensions:	

ID:	10
Title:	Join Online Interview
Description:	Candidate joins an online interview for a particular job posting he applied to
Primary Actor:	Candidate
Preconditions:	Candidate is logged into the system
Postconditions:	An analysis is performed of the candidate's performance during the interview to prepare a detailed report.
Main Success Scenario:	The candidate is logged into the system and joins an online interview for particular job posting he applied to. After completing the interview, an analysis is performed of the candidate performance to prepare a detailed report.
Extensions:	

Figure 3.17: Use Cases 9 and 10

3.5 Datasets

For some of the deep learning models, we will be working on datasets provided by the external supervisor.

- One of the datasets provided by the external supervisor is regarding a survey conducted under the supervision of psychometricians to determine the personality type of a specific individual. The survey consists of 142 questions that are used to identify a certain psychotype. There are around 12,000 responses from different individuals.

	q1	q2	q3	q137	q138	q139	q140	q141	q142	psychotype
1	0	0	0	1	1	1	0	0	0	ENFJ
2	0	1	1	1	0	0	0	0	1	ESTP
3	0	0	0	1	0	0	1	1	0	ESTP
4	0	0	1	0	0	0	0	1	1	INTJ
5	0	0	0	0	1	0	1	0	1	INFJ
6	0	0	1	1	1	1	0	0	1	ISFP
7	0	0	0	1	1	0	0	0	1	ENFP
8	1	0	0	1	0	1	0	1	1	ENFP
9	1	1	0	1	0	1	0	0	0	ISFP
10	0	0	0	0	1	0	0	0	1	ENTP
11	0	0	1	0	1	0	1	1	1	INTJ
12	0	0	0	1	1	0	0	0	1	ESTP
13	0	0	0	0	1	0	0	0	1	ENFP
14	1	0	1	1	1	0	0	1	1	INFP
15	0	1	0	1	1	0	1	0	1	ENFJ
16	1	1	0	1	1	1	0	0	1	ENFJ
17	1	0	1	1	1	1	0	1	0	ISFJ
18	0	0	1	1	1	0	0	0	1	ENTP
19	0	0	0	1	1	0	1	1	0	ENFP
20	1	0	1	1	1	0	0	0	1	INFP
21	1	1	0	1	1	1	1	1	1	ENFI
22	1	0	1	1	1	0	1	1	1	INTJ
23	1	1	1	1	1	1	1	1	0	INTJ
24	0	0	1	1	0	0	0	0	1	ESFP

Figure 3.18: Snippet of data from the dataset

- For our computer vision model, we will be training the model using the **Facial Emotion Recognition** dataset available on **Kaggle**. The data consists of 48x48 pixel grayscale images of faces. The faces have been automatically registered so that the face is more or less centred and occupies about the same amount of space in each image.

Note: This dataset is free to use and available for commercial use. Other datasets used for facial expression recognition are not available for commercial use.



Figure 3.19: Some examples from FER-2013 dataset

- For other cognitive ability tests, the external supervisor has taken the responsibility of providing the data after the development of other modules. The models developed using this data may serve as another additional module for the project.

3.6 System Diagram

This diagram gives a high-level view of the different components of our system and the interactions between them. Each component and the particular tools/technologies/libraries used to build it are described.

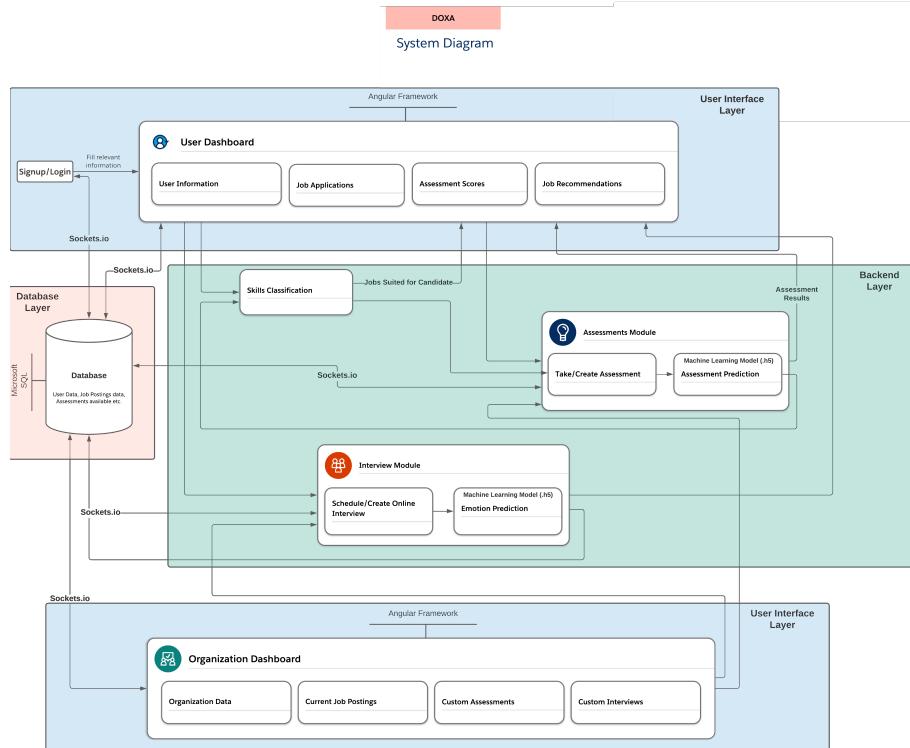


Figure 3.20: System Diagram of DOXA

4. Software Design Specification (SDS)

This chapter provides important artifacts related to design of our project.

4.1 Data Design

This section presents the structure of our database that caters to persistent data storage in our project. The structure is shown as a normalized data model for relational databases. It clearly shows entities, attributes, relationships with their cardinalities, and primary and foreign keys. We have used DB designer (or any other similar data modeling tool) to build our data model.

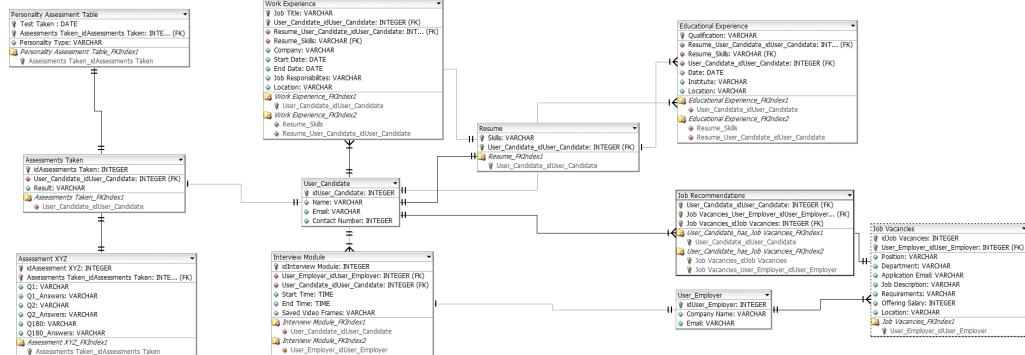


Figure 4.1: Database Entity Relationship Diagram

The database entity relationship diagram is used to describe the tables that will exist in the database and how they will relate to each other. Starting with the Candidate

User table, it will contain basic information of the user and will be related to the work and educational experience tables. The resume table will connect to the work and educational experience tables to pull each user's relevant data and use it to generate a resume.

The assessments module will consist of three tables. The assessments taken table will have a 1 to many relationship with the Candidate User table as a user can take multiple assessments. The Assessment XYZ table refers to each assessment's data that includes the questions and answers in it. Personality Assessments table is mainly used for storing the personality type of a user predicted by each assessment.

The job modules consists of three tables as well. The Employer User table contains information for an organization's account that will use the DOXA platform for recruitment. Job vacancies table, as the name suggests, is used for storing open job vacancies listed by organizations. The job recommendations table will contain jobs specified for each user by using the skills classification algorithm.

Finally the interview module table includes the times for an online interview conducted on the platform and the extracted video frames, to be used for emotion classification, from the live interview.

4.2 Technical Details

4.2.1 Module I

Model 1: Personality Type Prediction using survey responses

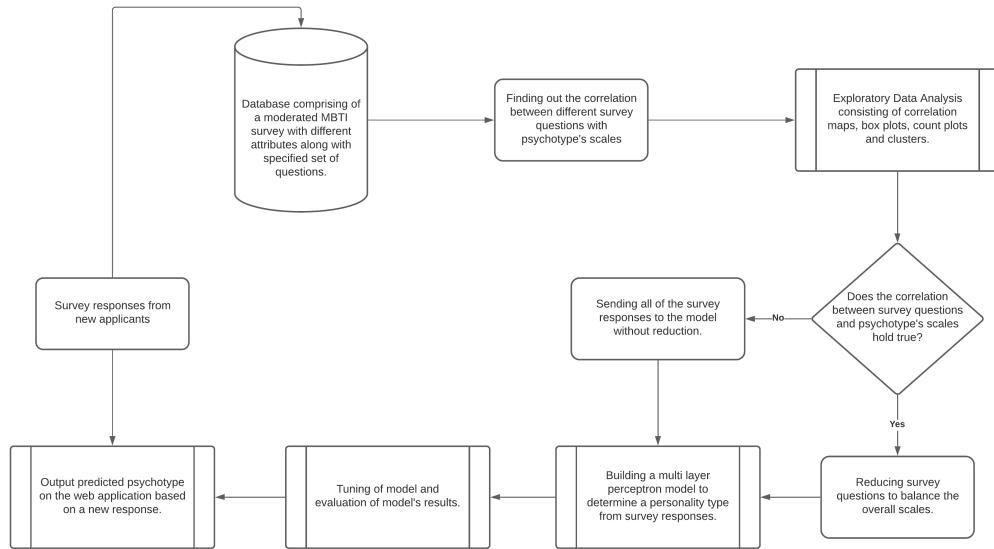


Figure 4.2: Model 1 Pipeline

This model aims to predict psychotypes based on responses from a Myers–Briggs Type Indicator (MBTI) moderated survey. The survey consists of more than a hundred questions with each having two available responses. The dataset available based on this survey consists of more than twenty thousand responses including a personality type for each candidate. Some personality scales were also available which can be used to specify the weight of each question with respect to a scale. The responses to the question for each individual are extracted and fed into the the multilayer perceptron model (MLP). An MLP is a feed-forward artificial neural network consisting of at least three layers, namely the input layer, hidden layer and the output layer. It calculates the probabilities for each psychotype, given a specific response from a candidate. After evaluating multiple responses, the psychotype with

the highest probability will be the predicted psychotype for a particular response from a candidate.

This predicted psychotype is then added to the candidate's profile and shown on the web application.

Model 2: Scoring Multiple Personality Traits using survey responses

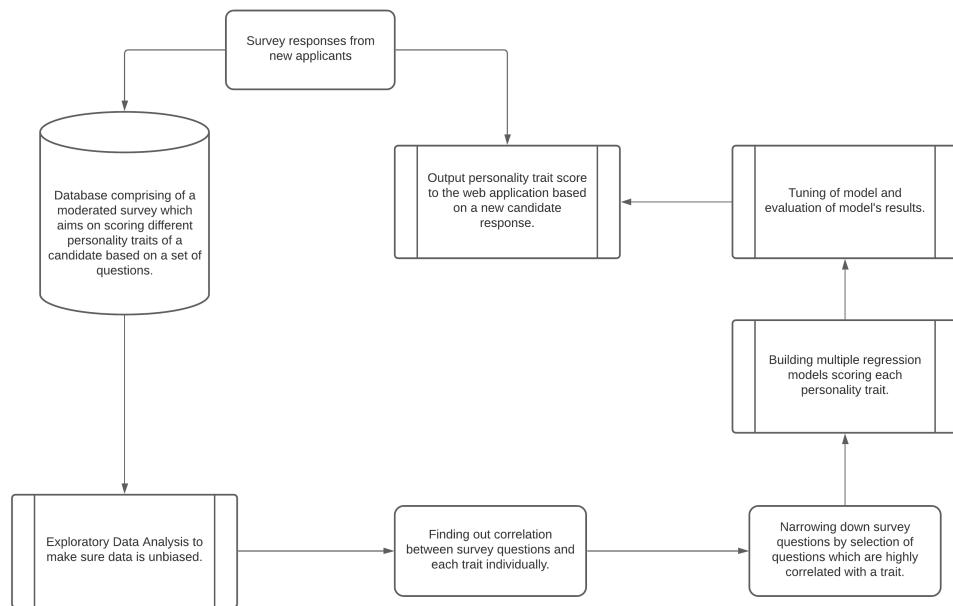


Figure 4.3: Model 2 Pipeline

This model aims to predict different personality traits based on responses from another moderated survey. This survey consists of more than hundred questions with each having around 7 possible responses. The dataset available based on this survey consists of around two thousand responses, each of which includes a score for several different personality traits. After some exploratory data analysis, the number of questions are cut down based on its correlation a certain personality trait. The responses to the remaining questions for each individual are extracted and fed into the the regression model. Regression models predict a value of a unknown variable

given values of known variables. Prediction within the range of values in the dataset used for model-fitting is known informally as interpolation. The regression model computes a probability for a specific trait and outputs it.

The predicted score is then added to the candidate's profile and shown on the web application.

4.2.2 Module II

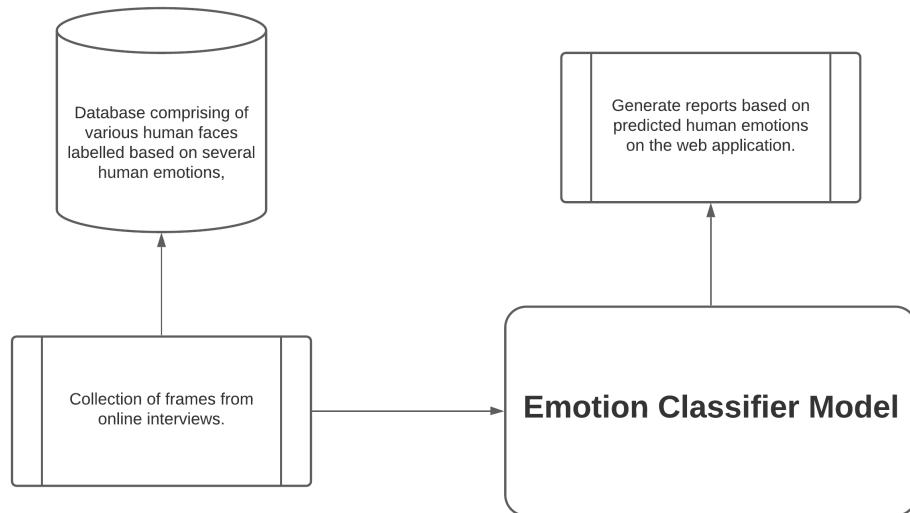


Figure 4.4: Module II Pipeline

This is mainly related to the interview module of the web application. Video frames are collected from the online interview of the candidate and fed into the emotion classifier model. The model then classifies each frame into an emotion and generates a report based on it. Finally, the output report is pushed to the web application to be used by employers/interviewers.

5. Experiments and Results

This chapter discusses results of our implemented models and the working of our web application.

5.1 Personality Assessment Models

The system utilizes 2 personality assessment models to evaluate a users personality. The first model is a multi-layered perceptron that determines the personality psychotype of a person. The second model is linear regression based model that scores personality traits of a person. Each model takes answers of a unique survey as inputs. The first model have an accuracy of 95% and the second model has an R2 score of 0.95 and mean-squared error of 13.05.

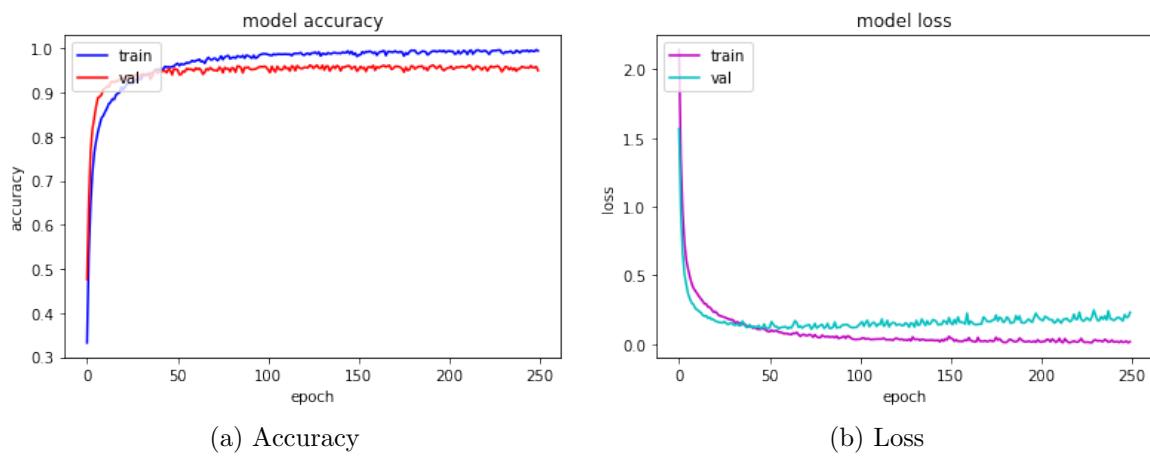


Figure 5.1: Model 1 Accuracy and Loss Plots

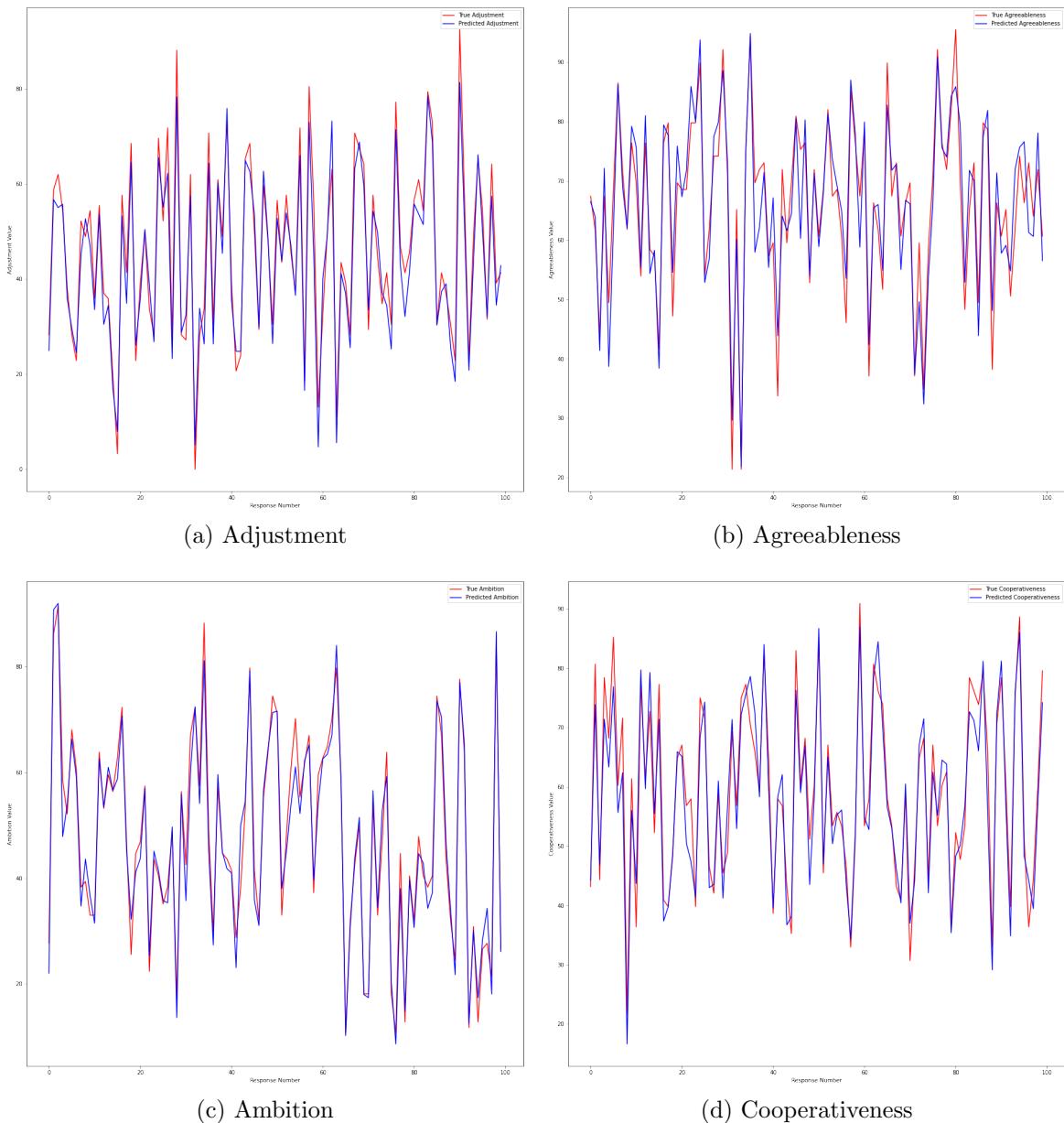


Figure 5.2: Model 2 Predictions for Personality traits (1)

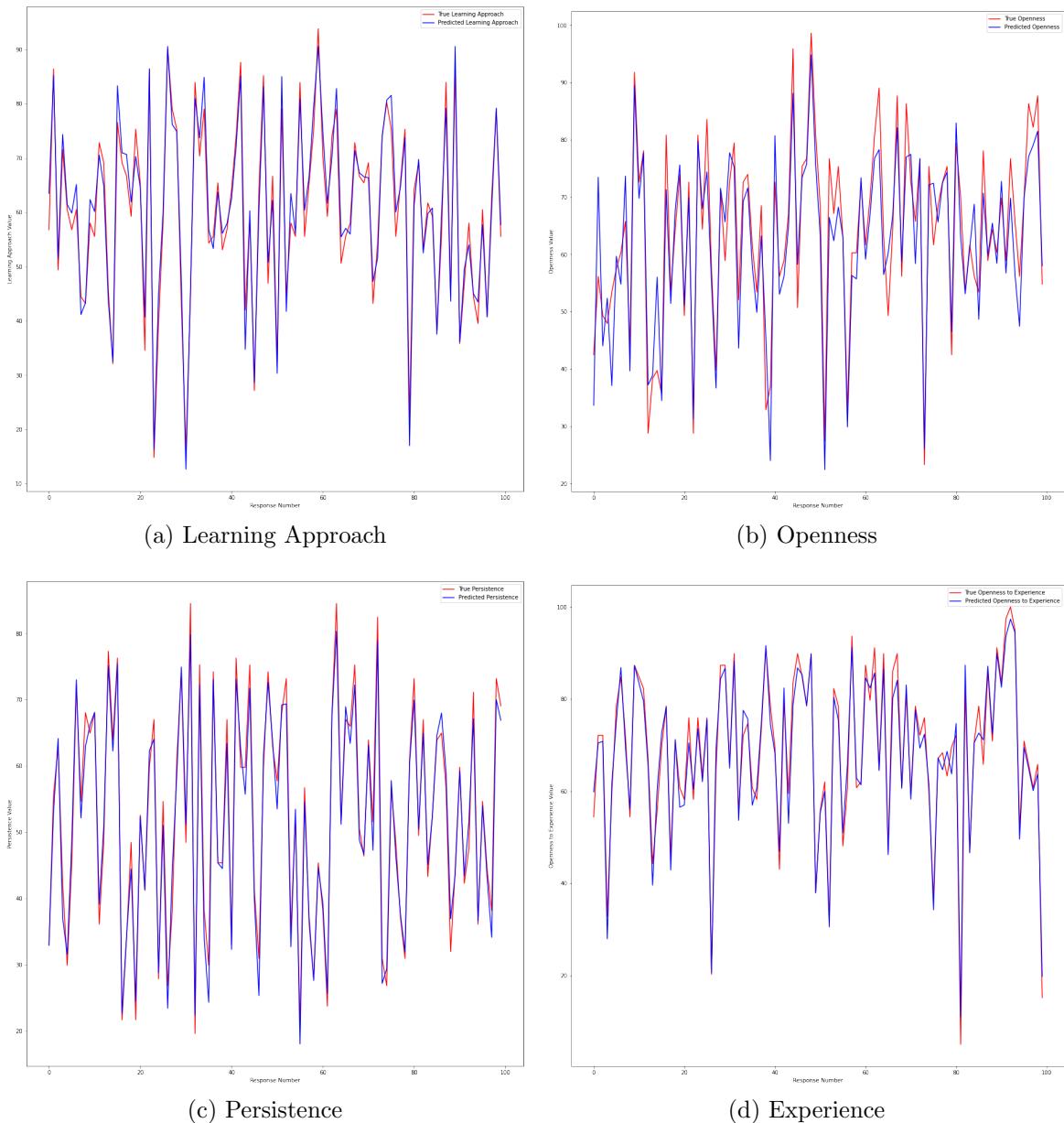


Figure 5.3: Model 2 Predictions for Personality traits (2)

5.2 Face Detection Model

The face detection model is utilized in our online interview portal where it detects faces to be passed on as input for the emotion detection model.

Face detection is now a standard task in many real-world applications, thus OpenCV - An Open Source Computer Vision Library - comes with a number of built-in functions for detecting faces, eyes, hands, legs, etc.

Face detection using OpenCV's Haarcascade is a machine learning based approach where a cascade function is trained with a set of input data. Like a series of waterfalls, the OpenCV cascade breaks the problem of detecting faces into multiple stages. A quick test is performed on a block of image. If the block passes, a slightly more complex test is performed, and so on. A face will only be detected if all the stages are passed.

Since the majority of the input image will return negative during the first few stages, the algorithm does not test all 6,000 features on all the blocks. Instead of taking hours, face detection is performed instantly and can be utilized in real-time applications.

5.3 Emotion Recognition Model

The emotion recognition model is utilized in our interview portal where it detects emotions of an applicant during the interview.

The model is a convolution neural network (CNN) that takes 48x48 pixel gray-scale images as inputs and outputs 1 of 7 emotions (happy, sad, neutral , angry, disgust, surprise, contempt). The model was trained on FER-2013 data set consisting of 35000+ labeled images. However, in Literature, the model trained on this data set reported an accuracy of only about 63%. In another paper [4] that worked on improving the accuracy of FER-2013 data set, pointed out mis-labeling as the primary source of error. In this paper 10 people were appointed to label all images according to their judgement. The data was compiled in a csv which we utilized to re-label all the images with the emotion that received the highest votes for that image. The model trained on the re-labeled data set achieved an accuracy of 76%.

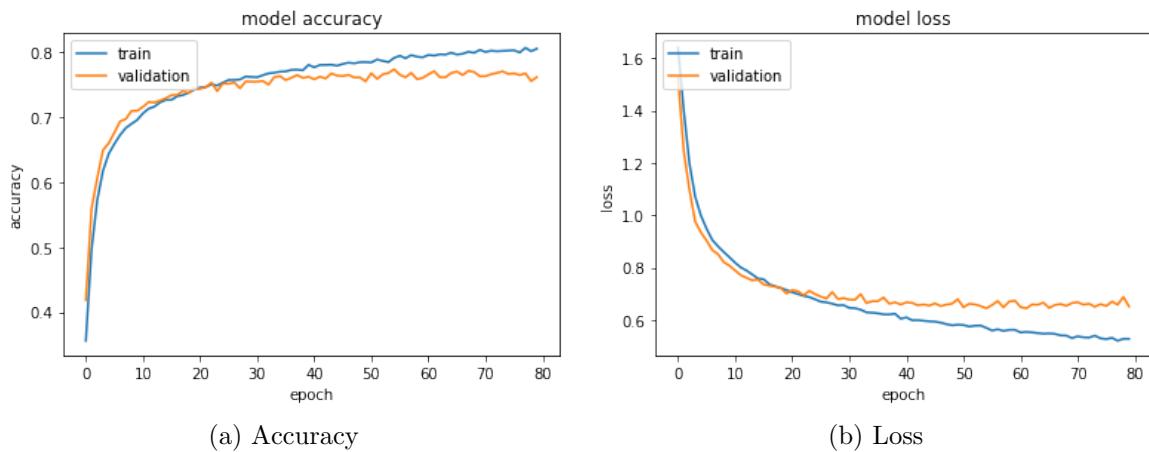


Figure 5.4: Model Accuracy and Loss Plots

5.4 Web Application

DOXA is designed as a User friendly Recruitment Assistance & Management System. The entry point into the system is the Login page, where a user can choose to login or sign up to the platform, as a candidate or a recruiter. When logging in the user credentials are validated from the database to confirm the identity of the user. Appropriate error messages are displayed in case of failure.

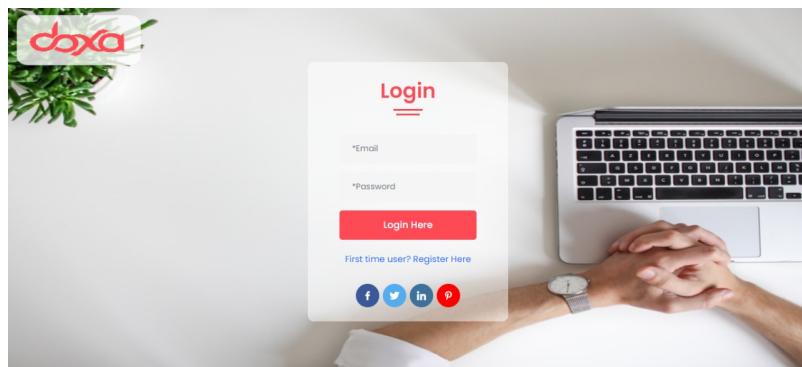


Figure 5.5: Login Page

As a logged-in user the dashboard is displayed, the rest of the system can be navigated via the nav-bar. The dashboard is populated with user data (e.g. Personal Information, Work Information, Jobs, Assessments, Offers etc.) fetched from the database. A user can update his information here which writes the new information in the database.

In the assessments page, the candidate can browse through all available tests. The scores of taken tests are saved in the database.

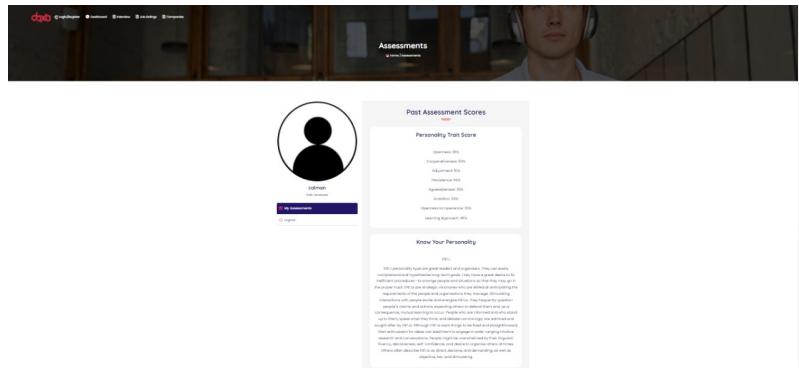


Figure 5.6: Assessments Page

In the Jobs Listing page, a recruiter can create new job postings while specifying requirements (including assessments) for the job. A candidate can explore and apply to all available job postings. The application process makes sure the candidate is eligible for the job, based on the requirements and sends the candidates resume to the recruiter immediately.

The recruiter can view all applications for a particular job posting as a collection of baseball cards. Each card is an overview of an applicant. The recruiter can either choose or discard applicants. An automatic email is sent to the chosen applicants inviting them to an online interview .

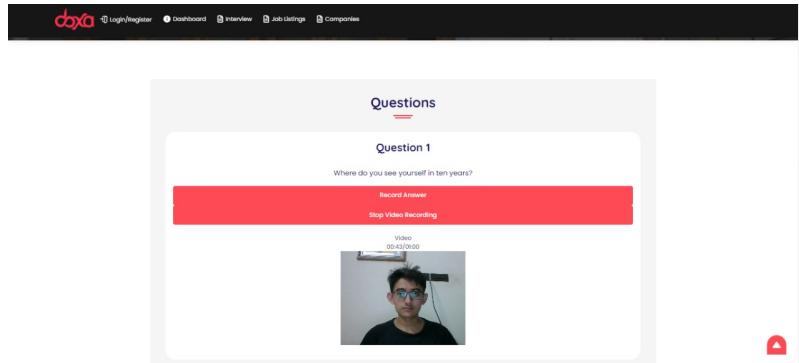


Figure 5.7: Interview Portal

In the interview portal a recruiter can set questions that the applicant must answer. Currently, the interviewer can set 3 questions, which can either be custom or can be chosen from a bank of 10.

In the interview an applicant must provide a 1 min response for each of the questions. Each response is recorded and stored in the database. Frames from the responses are input into the face detection model to extract faces which are then input into the emotion recognition model to perform sentiment analysis of the applicant during the interview. A report is generated detailing the stats about applicants performance (e.g. confidence levels). The report is then saved in the database.

A recruiter can access the recorded response and sentiment analysis report of each applicant appearing for the interview. He can then schedule simple interviews or/and send an offer letter. The applicant can choose to accept or decline offers.

6. Conclusion and Future Work

Our AI-powered recruitment assistant is a tool that can help organizations to streamline their recruitment process and improve the quality of their hires. The assistant can help to identify potential candidates, screen resumes, and conduct initial interviews. The assistant can also help to provide feedback to the organization on the quality of the candidates. The AI-powered recruitment assistant has the potential to improve the efficiency and effectiveness of the recruitment process and to help organizations to make better hiring decisions.

The Myers-Briggs Type Indicator (MBTI) is a personality test that can help in hiring decisions by providing insights into how a candidate perceives and processes information. By employing the MBTI and models learnt responses data from other personality trait tests, DOXA can help identify candidates who are a good fit for a particular position or company culture. It can also help to identify potential areas of conflict between a candidate and a position.

The DOXA team visited the annual Habib University Career Fair, held on the 22nd of March, 2022. and garnered positive feedback on the project. 90% of the recruiters expressed their excitement on the product and labelled it as "cool" and shared that they would be "very excited" and "definitely willing to pay" for such a service. The remaining 10% of the recruiters surveyed expressed unfamiliarity regarding the MBTI test and how they can use it to optimize their hiring decisions and hence were reluctant on paying for the service; however, they also elaborated that a proper briefing and training can be helpful in making them more comfortable and accepting towards the product.

The product we have developed is at a very primitive stage of what can be. We aim to include chat options for quicker communication between the recruiter and

the shortlisted candidates. We also aim to build recommender systems once we have collected enough data to generate efficient recommendations. We also aim to launch a mobile app version of the product with a very interactive and smooth user interface in order to help recruiters and candidates access our application from the comfort of their mobile phones.

Appendix A. Data

Links for our data are given below:

1. <https://github.com/m-sabihul-hasan/DOXA-FYP/blob/main/Model%201/data.csv>
2. <https://github.com/m-sabihul-hasan/DOXA-FYP/blob/main/Model%201/temp.xlsx>
3. <https://github.com/m-sabihul-hasan/DOXA-FYP/blob/main/Model%202/CorrelatedQs.txt>
4. <https://github.com/m-sabihul-hasan/DOXA-FYP/blob/main/Model%202/data.csv>
5. https://github.com/m-sabihul-hasan/DOXA-FYP/blob/main/Model%202/data_output.csv
6. <https://github.com/m-sabihul-hasan/DOXA-FYP/blob/main/Model%202/questions.csv>
7. <https://github.com/m-sabihul-hasan/DOXA-FYP/blob/main/Model%202/temp.xlsx>
8. <https://github.com/m-sabihul-hasan/DOXA-FYP/blob/main/Model%202/traits.csv>
9. <https://github.com/m-sabihul-hasan/DOXA-FYP/blob/main/Model%203/fer2013new.csv>

Appendix B. Code

Our code can be found at <https://github.com/m-sabihul-hasan/DOXA-FYP>.

References

- [1] “9 Benefits to Hiring the Right Candidate the First Time Around”. In: *TalentClick* (2018).
- [2] David J Anderson and Ralph Adolphs. “A framework for studying emotions across species”. In: *Cell* 157.1 (2014), pp. 187–200.
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